The Development of the Apple from the Flower

THE VALUE OF THE HONEYBEE AS A FERTILIZING AGENT

BY

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PREFACE

This article, reprinted from "Better Fruit," and written by Mr. O. M. Osborne, the head of the Horticultural Department of State Normal School of Idaho, sets forth in a most convincing and conclusive manner the value of the honeybee as a fertilizing agent, and the fact that the grower of apples especially is almost entirely dependent on the actions of our busy little friends for his crop of apples.

For many years we have had to combat the old idea that bees are inimical to the interests of the fruit-grower, a notion which, we are happy to say, has almost entirely been dispelled—then came a time when fruit-growers began to realize that the bee-keeper's and fruit-grower's interests were mutual, and now scientists are proving, beyond the peradventure of a doubt, that the honeybee is not only not harmful to the fruit-grower, but that they are an absolute necessity for the proper fertilization of some flowers, for example, apple-blossoms.

But Mr. Osborne goes a step further and insists that not only is it absolutely necessary to keep bees in order to obtain a good yield of apples, but that there should be a sufficiently large number of colonies in the orchard, in order that each and every apple-blossom might be benefited and receive its share of the fertilizing pollen.

We earnestly commend this article to every fruit-grower and more especially to the growers of apples, as well as to all bee-keepers, in order that they may enlighten such of their friends as are interested in fruit culture.

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HOW THE HONEYBEES FERTILIZE THE BLOSSOMS.

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The development of the apple from the flower is a very complex biological process. The study of this development has been entirely limited in the past to the field of botany. It is now, however, demanding a close and careful study from all of the horticulturists throughout the world, for it has been found that the size and shape of the fruit, the yield per acre, and the time for spraying are all dependent upon environmental conditions during blossoming time that are to a great extent under the control of man. To understand these environmental conditions, let us begin with the flower itself. In plate I is a longitudinal section of a fully opened blossom. If each part is carefully studied it will be found that every one has an important part to play in the formation and development of the fruit. Although not constituting any part of the fruit, and although dropping off within a few days, the beautiful white and pink petals serve as an attraction for the honeybees which visit the flower to obtain the nectar from the nectar-glands. The nectar-glands are not shown in this cut, but they lie at the base of the petals on the inner side. After nectar has undergone a partial digestion inside the bee it becomes honey.

THE DEVELOPMENT OF THE APPLE FROM THE FLOWER

While climbing about the flower to reach the nectar the bee brushes against the stamens, or the male parts of the flower. From the little sac-like enlargements or anthers at the top of the stamens it receives a deposit of a powdery substance called pollen (the fecundating cells). You are likely familiar with the sight of a bee laden with pollen. If the little winged creature is closely examined it will be found that it carries the

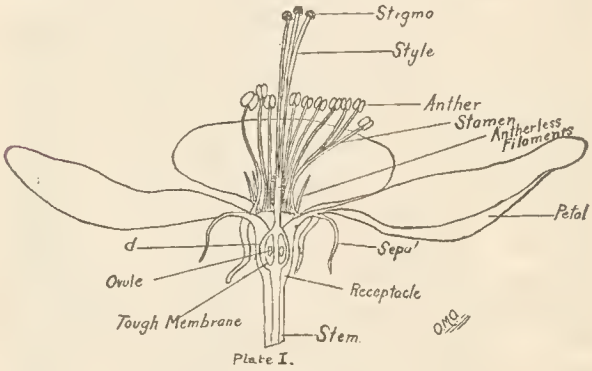
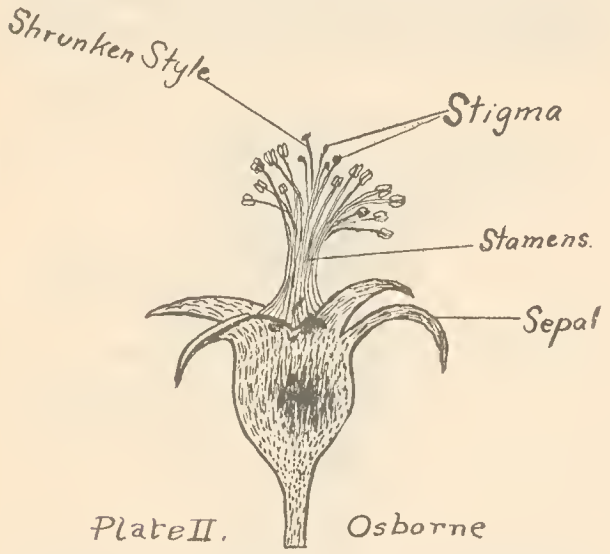


Plate I.

pollen in little collecting-baskets formed of stiff hairs on the tibia of each hind leg. Under a low-power hand lens it can be seen that the pollen catches on to other parts of the bee's body. Now, when the bee rises to fly to a second flower (and it visits only one kind of a flower on a single trip) it may brush off a little pollen on the top of the stigma of the first flower; but since the stigma is raised above the stamens, as shown in the accompanying diagram, the chances are not as great as when the bee alights on a second flower. When it alights on the second

flower it is almost certain to brush off a little pollen upon it, due to the stigma being situated above the anthers, as shown in the diagram. The pollen so deposited adheres readily on account of a sticky substance upon the stigma. Hence the flower invites through its friend, the bee, cross-pollination, and aims



to prevent self-pollination by having the stigmas located far above the anthers, as before mentioned.

WHY THE APPLE-BLOSSOM IS ENTIRELY DEPENDENT ON THE BEE FOR ITS FERTILIZATION.

Without the aid of the bees but very little, if any, pollen would ever reach the stigma, for the pollen of the apple is a trifle sticky, and, unlike that of the corn tassle, ragweed, and several other familiar plants which are powdery, it cannot be distributed by the wind.

After the pollen has been deposited upon the stigma each individual grain begins to expand, due to the food and the stimulus present in the sticky sugary substance on the stigma. Soon each grain sends out a tube called a pollen tube, which penetrates the top of the stigma and grows down through the style to the ovary, where it reaches the ovules shown in the diagram. It here pene-

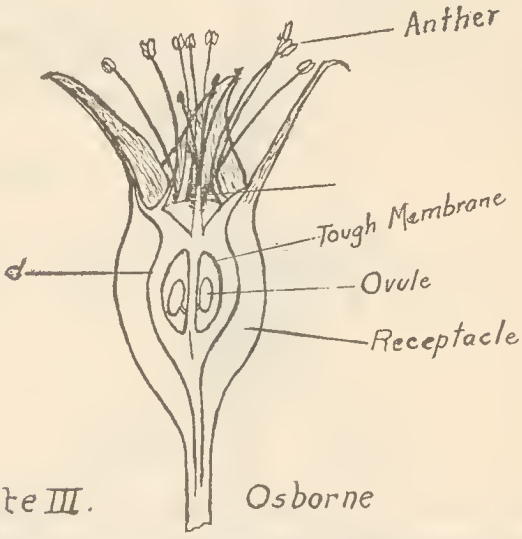


Plate III. Osborne

trates a very minute opening at the apex of the ovule, called the micropyle, and transfers a male nucleus into the egg cell within the ovule. The male sexual nucleus there unites with the female nucleus of the egg cell and completes the process of fertilization. From this union develops a cell containing protoplasm, the nitrogenous living substance of which the most rapidly growing parts of plants are mainly composed. Each little ovule in which this pollination took place gradually develops into an apple seed. The

different stages of this seed development are shown in the series of plates Nos. I, III, V, VI.

HOW THE FLOWERS AND THE BEES CO-OPERATE FOR EACH OTHER'S GOOD.

By experimentation extending through a number of years it has been found that if

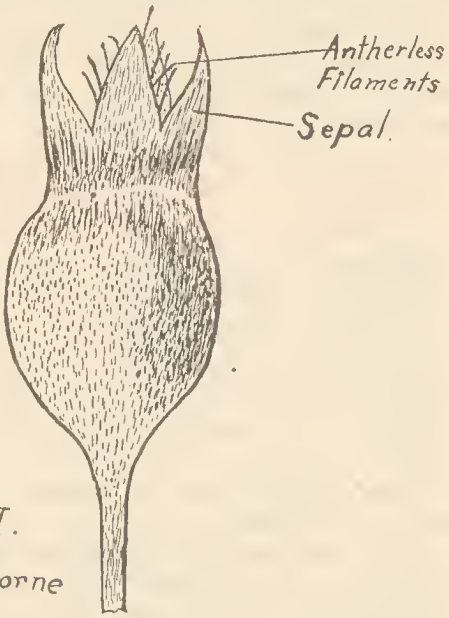


Plate IV.
Osborne

many of the ovules in the apple flower fail to become fertilized (which, of course, results in undeveloped seeds) the apple will either lack size or symmetry, or both. Since this condition is true, the fruit-grower should endeavor to furnish conditions which will cause every flower which is to bear fruit to become thoroughly fertilized. To bring about good fertilization, thorough pollina-

tion is absolutely necessary. What does the process of pollination mean to the fruit-grower? It means that it is a potent factor, first, in the quantity of production, and, second, in the size and shape of the fruit. It is a process in which the flowers and the bees co-operate for each other's good, a process which is often termed symbiosis. It is a process where a member of the plant kingdom has modified its structure for the purpose of reaping a benefit from a member of the animal kingdom (in this case the honeybee) as a pollen-distributor and has offered the sweet nectar as a reward.

HOW MANY COLONIES OF BEES ARE NEEDED FOR THE PROPER DEVELOPMENT OF AN ORCHARD?

Since the pollination of the apple flowers is performed almost solely by the honeybee it behooves the fruit-grower to have bees in abundance in his orchard. It can be determined only experimentally whether or not the number of bees existing in an orchard is sufficient. The experiment may be performed by the fruit-grower by placing a hive of bees at one end or in one corner of a large orchard and then observing the amount and shape of the fruit set. This method of determining whether bees are in sufficient abundance is, of course, expensive, for any lack of them results in a shortening of the fruit crop. Hence it is well to insure against the possibility of loss by keeping a few hives of bees distributed through the orchard. Bees not only will often increase the quality and quantity of the fruit, but incidentally will furnish the fruit-grower with wax for grafting, and with honey for the home.

While bees are necessary in every orchard to carry on the work of pollination, successful pollination can occur only where the different varieties are set out with reference to the time of blossoming. Only certain varieties of apples will pollinize well together. It is, therefore, obvious that their time of blosoming must be the same. In order to produce fruit, not only should the

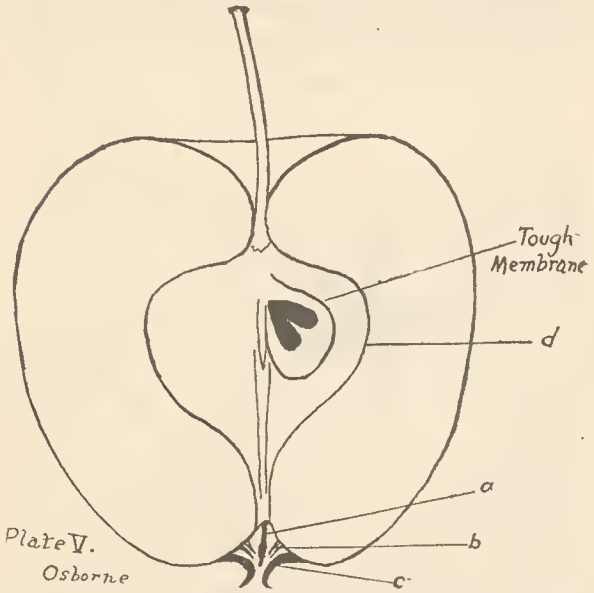
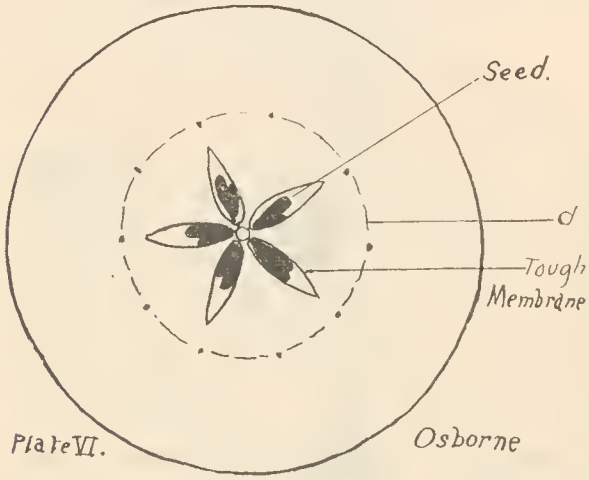


Plate V.
Osborne

time of blossoming be the same, but the flowers of any one variety must be capable of either being fertilized by their own pollen or by the pollen of some closely related variety. We thus have those that are termed self-fertile (fertile to their own pollen) and those that are termed self-sterile (sterile to their own pollen). There are also varieties which are only partially self-sterile. Due, perhaps, to environmental conditions, the

class to which any one variety of apples belongs varies in different localities. Not only do the environmental conditions represented by climate and soil determine the class to which any variety of apples belongs, but they even determinte the quantity of pollen produced. Hence it becomes of especial scientific interest to us when we consider that these environmental factors influence the characteristics and behavior of the germ-cell of the plant. By writing to your State ex-



periment station you can usually obtain a list of the apples which pollinate well together, and of those that blossom at the same time. Such a list becomes very valuable for reference at the time of planting an orchard.

Let us consider the changes in the fertilized flower after the petals have fallen and their relation to orchard spraying. By examining plates Nos. II and III it will be seen that the changes that are evident in

the remainder of the flower are shown in the way of a shrunken style and stigma, in the open and empty anther sacs which contained the pollen and in the somewhat larger receptacle. Now let us examine plate No. IV. In this we find that the sepals are turning inward, due to the enlargement of that part of the original flower in plate No. I, termed the receptacle. It is the receptacle of the flower which develops into the edible portion of the apple as shown in plate No. II, and the corresponding parts in plates Nos. V and VI.

Our rules for spraying for the codling moth tell us that the first spraying should take place immediately after the petals fall, and that the calyx (the sepals taken together constitute the calyx) should be well filled with the poison. From an examination of plate No. IV it can readily be seen that the turning-in of the sepals as the little apple develops from the flower directs a spray away from the calyx cavity. A few days later in its development the sepals form a sort of cone-like roof over the calyx cavity much like that of a mature apple, as shown at "c" in plate No. V. It can also be seen by a close examination of plate No. II that the larva of a newly hatched moth has but a small distance to eat to reach the center of the little apple during the early stages of its growth. It is also noticeable that the calyx cavity during the early stages is quite pointed; hence, if the poison is well placed during spraying, the larva is sure to eat it in its endeavor to reach the inside of the apple. Thus we find that each part of the flower after unfolding from the bud gradually

passes through natural changes in developing into the apple. These changes not only have a highly complex and interesting biological significance from the standpoint of the lovers of nature, but also have a practical relationship to the management of the orchard and to the quantity and quality of the fruit produced.
